Apprenticeship and Industry Training

Communication Technician

Apprenticeship Course Outline

2213 (2013)

Alberta

Apprenticeship and Industry Training

ALBERTA ENTERPRISE AND ADVANCED EDUCATION

Communication technician : apprenticeship course outline:

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Communication Technician
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Course Outline

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Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding an employer. Employers hire apprentices, pay their wages and provide on-the-job training and work experience. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyperson or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution – usually a college or technical institute.

To become certified journeypersons, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board on the recommendation of Communication Technician Provincial Apprenticeship Committee.

The graduate of the Communication Technician apprenticeship program is a certified journeyperson who will be able:

- supervise, train and coach apprentices
- use a thorough knowledge of electrical and electronic theory and its application to communication and associated equipment used in the telecommunication industry
- understand different circuit combinations and components
- competently use test instruments and understand their capabilities and limitations
- competently carry out mechanical functions required when completing repairs
- competently use test procedures to locate faults and isolate defective components
- set up and maintain local area networks, voice & data networks and wireless systems
- integrate emerging technology with existing technology and equipment
- read and interpret drawings, plans and specifications and layout and develop projects according to specifications
- co-ordinate communication work within the scope of the Communication Technician trade and other trades employed in the industry in both installation and maintenance settings
- perform assigned tasks in accordance with quality and production standards required by industry

Apprenticeship and Industry Training System

Industry-Driven

Alberta's apprenticeship and industry training system is an industry-driven system that ensures a highly skilled, internationally competitive workforce in more than 50 designated trades and occupations. This workforce supports the economic progress of Alberta and its competitive role in the global market. Industry (employers and employees) establishes training and certification standards and provides direction to the system through an industry committee network and the Alberta Apprenticeship and Industry Training Board. The Alberta government provides the legislative framework and administrative support for the apprenticeship and industry training system.

Alberta Apprenticeship and Industry Training Board

The Alberta Apprenticeship and Industry Training Board provides a leadership role in developing Alberta's highly skilled and trained workforce. The board's primary responsibility is to establish the standards and requirements for training and certification in programs under the Apprenticeship and Industry Training Act. The board also provides advice to the Minister of Advanced Education on the needs of Alberta's labour market for skilled and trained workers, and the designation of trades and occupations.

The thirteen-member board consists of a chair, eight members representing trades and four members representing other industries. There are equal numbers of employer and employee representatives.

Industry Committee Network

Alberta's apprenticeship and industry training system relies on a network of industry committees, including local and provincial apprenticeship committees in the designated trades, and occupational committees in the designated occupations. The network also includes other committees such as provisional committees that are established before the designation of a new trade or occupation comes into effect. All trade committees are composed of equal numbers of employer and employee representatives. The industry committee network is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the board can set up a local apprenticeship committee. The board appoints equal numbers of employee and employer representatives for terms of up to three years. The committee appoints a member as presiding officer. Local apprenticeship committees:

- monitor apprenticeship programs and the progress of apprentices in their trade, at the local level
- make recommendations to their trade's provincial apprenticeship committee (PAC) about apprenticeship and certification in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- make recommendations to the board about the appointment of members to their trade's PAC
- help settle certain kinds of disagreements between apprentices and their employers
- carry out functions assigned by their trade's PAC or the board

Provincial Apprenticeship Committees (PAC)

The board establishes a provincial apprenticeship committee for each trade. It appoints an equal number of employer and employee representatives, and, on the PAC's recommendation, a presiding officer - each for a maximum of two terms of up to three years. Most PACs have nine members but can have as many as twenty-one. Provincial apprenticeship committees:

- Make recommendations to the board about:
    - standards and requirements for training and certification in their trade
    - courses and examinations in their trade
    - apprenticeship and certification
    - designation of trades and occupations
    - regulations and orders under the Apprenticeship and Industry Training Act
- monitor the activities of local apprenticeship committees in their trade
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- consult with other committees under the Apprenticeship and Industry Training Act about apprenticeship programs, training and certification and facilitate cooperation between different trades and occupations
- consult with organizations, associations and people who have an interest in their trade and with employers and employees in their trade
- may participate in resolving certain disagreements between employers and employees
- carry out functions assigned by the board

Communication Technician PAC Members at the Time of Publication

Mr. D. Chambers	Hinton	Presiding Officer
Mr. T. Young	Edmonton	Employer
Mr. J. Candy	Edmonton	Employer
Mr. J. Kelly	Wetaskiwin	Employer
Mr. A. Peterson	Calgary	Employer
Mr. R. Beck	Ft. McMurray	Employee
Mr. W. Boogaart	Crossfield	Employee
Mr. I. Gilkes	Calgary	Employee

Alberta Government

Alberta Advanced Education works with industry, employer and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and employers
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

Technical Institutes and Colleges

The technical institutes and colleges are key participants in Alberta's apprenticeship and industry training system. They work with the board, industry committees and Alberta Advanced Education to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs. They develop lesson plans from the course outlines established by industry and provide technical training to apprentices.

Apprenticeship Safety

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

Alberta Apprenticeship and Industry Training Board Safety Policy

The Alberta Apprenticeship and Industry Training Board (board) fully supports safe learning and working environments and emphasizes the importance of safety awareness and education throughout apprenticeship training- in both on-the- job training and technical training. The board also recognizes that safety awareness and education begins on the first day of on-the-job training and thereby is the initial and ongoing responsibility of the employer and the apprentice as required under workplace health and safety training. However the board encourages that safe workplace behavior is modeled not only during on-the-job training but also during all aspects of technical training, in particular, shop or lab instruction. Therefore the board recognizes that safety awareness and training in apprenticeship technical training reinforces, but does not replace, employer safety training that is required under workplace health and safety legislation.

The board has established a policy with respect to safety awareness and training:

> **The board promotes and supports safe workplaces, which embody a culture of safety for all apprentices, employers and employees. Employer required safety training is the responsibility of the employer and the apprentice, as required under legislation other than the *Apprenticeship and Industry Training Act*.**

The board's complete document on its 'Apprenticeship Safety Training Policy' is available at www.tradesecrets.alberta.ca; access the website and conduct a search for 'safety training policy'.

Implementation of the policy includes three common safety learning outcomes and objectives for all trade course outlines. These common learning outcomes ensure that each course outline utilizes common language consistent with workplace health and safety terminology. Under the title of 'Standard Workplace Safety', this first section of each trade course outline enables the delivery of generic safety training; technical training providers will provide trade specific examples related to the content delivery of course outline safety training.

Occupational Health and Safety

A tradesperson is often exposed to more hazards than any other person in the work force and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Occupational Health and Safety (A division of Alberta Human Services) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.humanservice.alberta.ca

Technical Training

Apprenticeship technical training is delivered by the technical institutes and many colleges in the public post-secondary system throughout Alberta. The colleges and institutes are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All training providers place great emphasis on safe technical practices that complement safe workplace practices and help to develop a skilled, safe workforce.

The following institutions deliver Communication Technician apprenticeship technical training:

- Northern Alberta Institute of Technology
- Southern Alberta Institute of Technology

Procedures for Recommending Revisions to the Course Outline

Advanced Education and Technology has prepared this course outline in partnership with the Communication Technician Provincial Apprenticeship Committee.

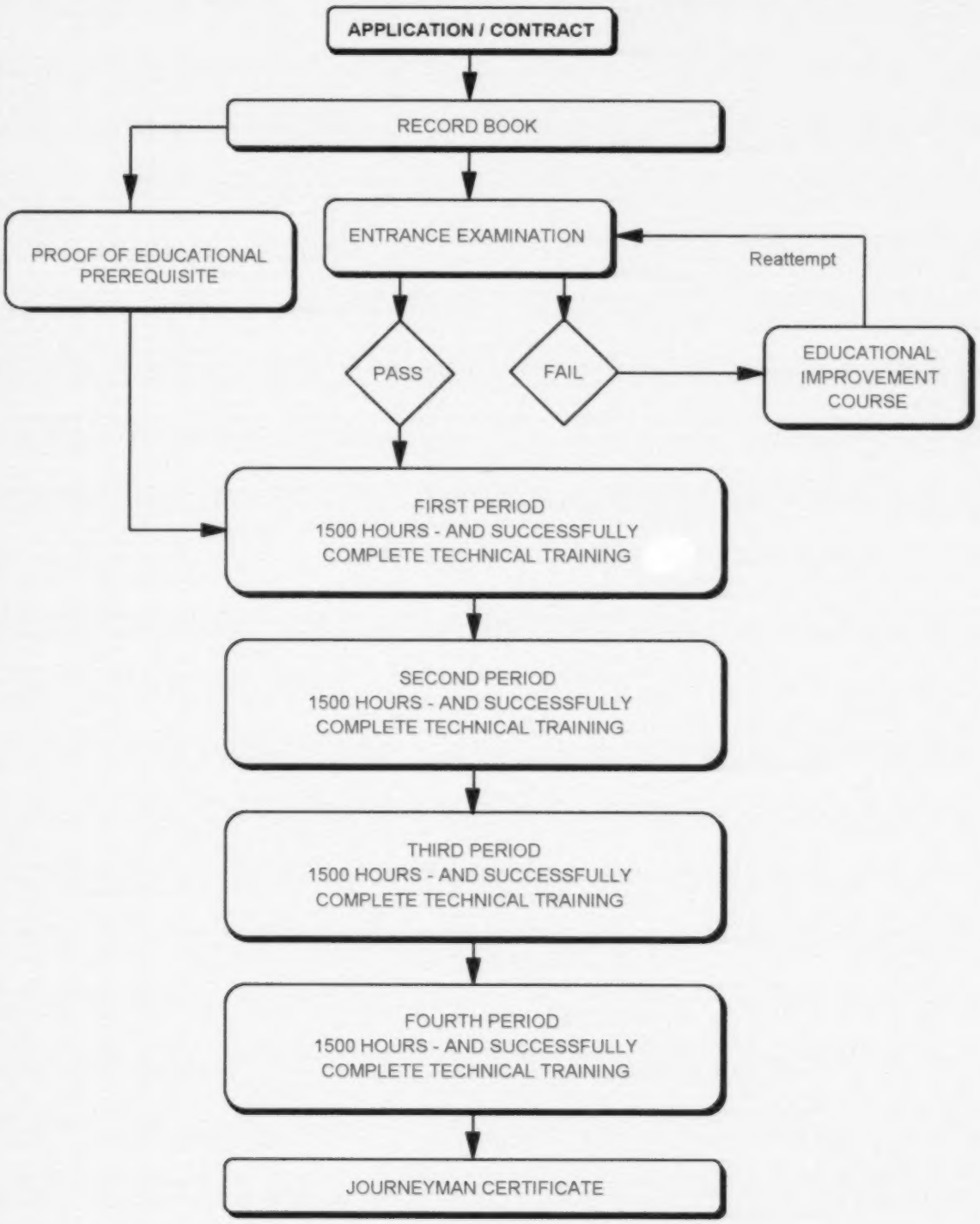
This course outline was approved on November 12, 2012 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

Communication Technician Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
Advanced Education
10th floor, Commerce Place
10155 102 Street NW
Edmonton AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations for change will be placed on the agenda for regular meetings of the Communication Technician Provincial Apprenticeship Committee.

Apprenticeship Route toward Certification



Communication Technician Training Profile
FIRST PERIOD
(6 Weeks 30 Hours per Week – Total of 180 Hours)

SECTION ONE

STANDARD WORKPLACE SAFETY — **10 HOURS**

A	B	C
Safety Legislation, Regulations & Industry Policy in the Trades — 3 Hours	Climbing, Lifting, Rigging and Hoisting — 3 Hours	Hazardous Materials & Fire Protection — 2 Hours

D
Lab Safety Awareness and Hazardous Materials — 2 Hours

SECTION TWO

BASIC ELECTRICITY — **52 HOURS**

A	B	C
Electricity Fundamentals — 8 Hours	Passive Electrical Components — 8 Hours	DC Circuits — 8 Hours

D	E	F
Small Signal AC Circuits — 6 Hours	Analytical Troubleshooting — 4 Hours	Basic Electricity Lab — 18 Hours

SECTION THREE

TRADE MATHEMATICS — **12 HOURS**

A	B
Advanced Mathematical Topics — 8 Hours	Alternative Numbering Systems — 4 Hours

SECTION FOUR

CABLE PLANT ARCHITECTURE I — **42 HOURS**

A	B	C
Cabling Standards — 4 Hours	Outside Plant Architecture — 12 Hours	Inside Plant Architecture — 12 Hours

D	E
Bonding and Grounding — 2 Hours	Cabling Lab — 12 Hours

SECTION FIVE

TELEPHONY — **28 HOURS**

A	B	C
Communication Network Overview and Terms — 4 Hours	Basic Telephone Line — 2 Hours	Basic Telephone Set — 3 Hours

D	E	F
Telecommunications Systems — 3 Hours	Basic Switching System Functions — 6 Hours	Basic Customer Terminal Equipment — 2 Hours

G
Basic Telephony Lab — 8 Hours

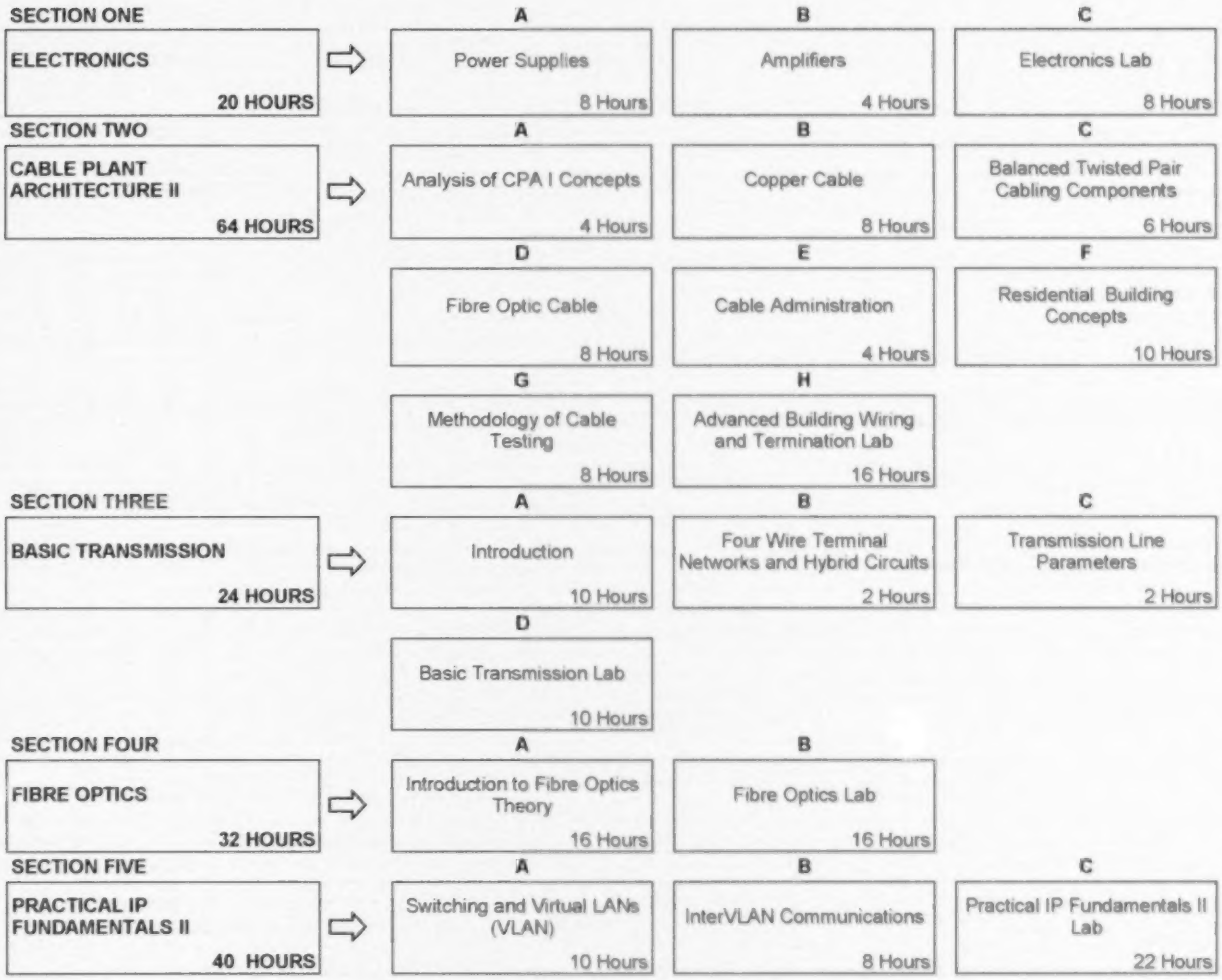
SECTION SIX

PRACTICAL IP FUNDAMENTALS I — **36 HOURS**

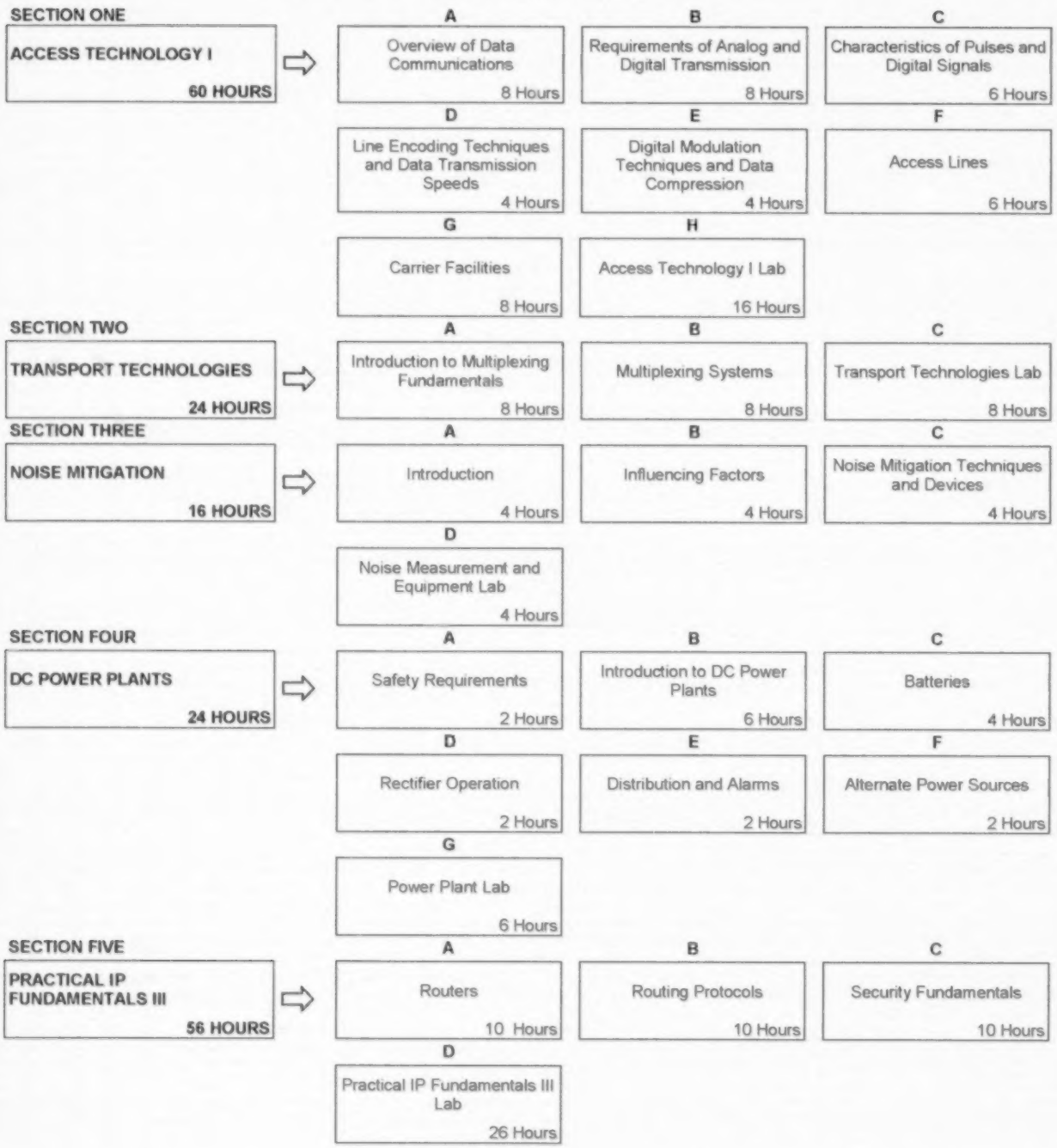
A	B	C
Network Fundamentals — 8 Hours	Networking Standards — 6 Hours	Network Devices — 10 Hours

D	E
IPv4 Addressing — 4 Hours	Network Lab — 8 Hours

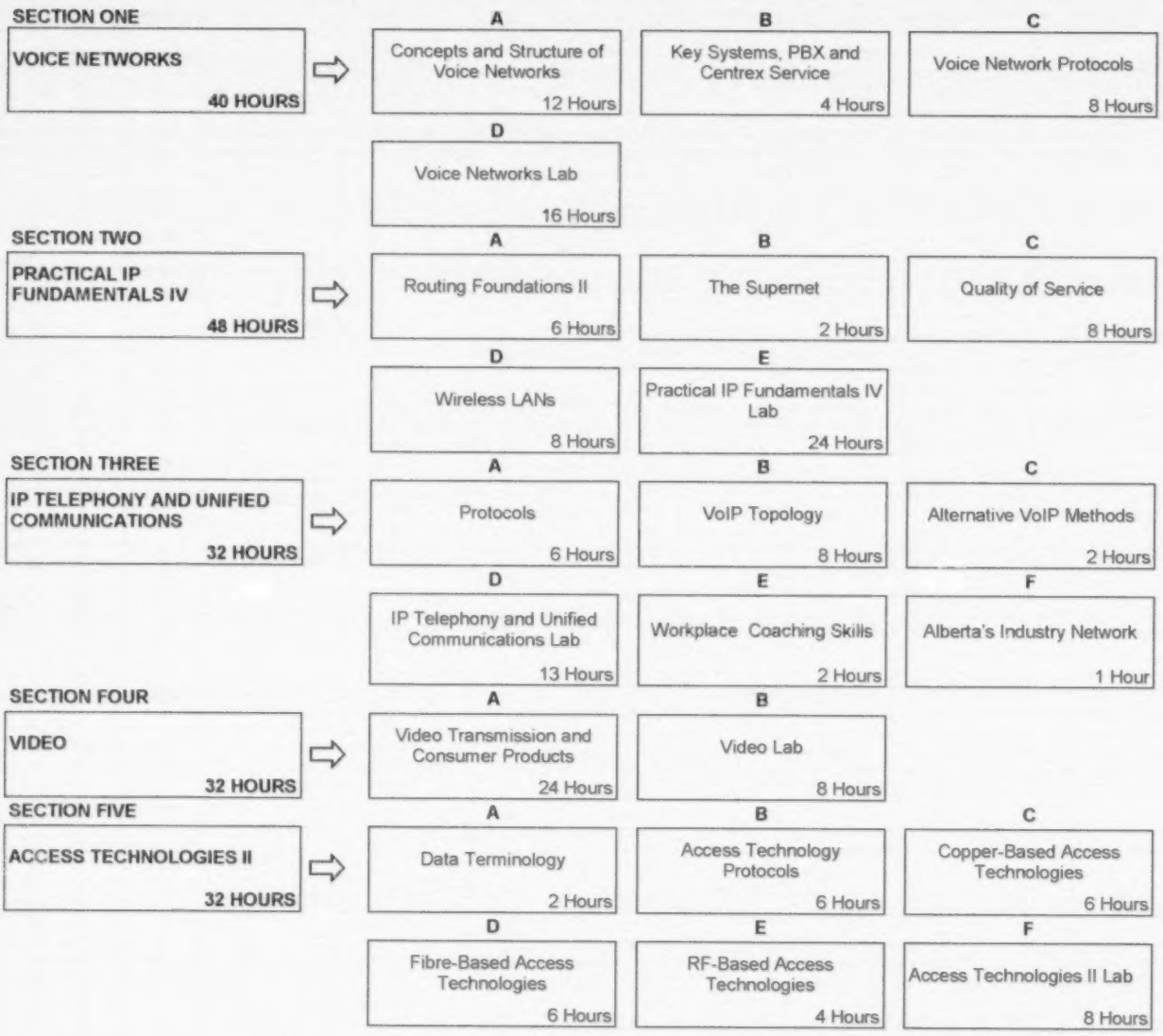
SECOND PERIOD
(6 Weeks 30 Hours per Week – Total of 180 Hours)

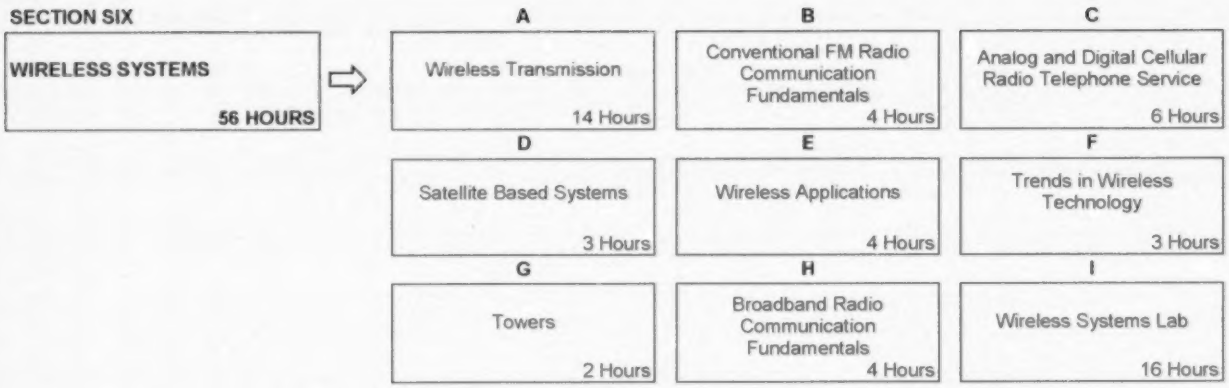


THIRD PERIOD
(6 Weeks 30 Hours per Week – Total of 180 Hours)



FOURTH PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)





NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training.

FIRST PERIOD TECHNICAL TRAINING
COMMUNICATION TECHNICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: .....STANDARD WORKPLACE SAFETY.....10 HOURS

A. Safety Legislation, Regulations & Industry Policy in the Trades .....3 Hours

Outcome: ***Describe legislation, regulations and practices intended to ensure a safe work place in the communication technician trade.***

1. Demonstrate the ability to apply the Occupational Health and Safety Act, Regulation and Code.
2. Explain the role of the employer and employee in regard to Occupational Health and Safety (OH&S) regulations, Worksite Hazardous Materials Information System (WHMIS), fire regulations, Workers Compensation Board regulations, and related advisory bodies and agencies.
3. Explain industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of workers and employers to apply emergency procedures.
5. Describe positive tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of employers and employees with respect to the selection and use of personal protective equipment (PPE).
7. Select, use and maintain appropriate PPE for worksite applications.

B. Climbing, Lifting, Rigging and Hoisting .....3 Hours

Outcome: ***Describe the use of personal protective equipment (PPE) and safe practices for climbing, lifting, rigging and hoisting in the communication technician trade.***

1. Select, use and maintain specialized personal protective equipment (PPE) for climbing, lifting and load moving equipment.
2. Describe manual lifting procedures using correct body mechanics.
3. Describe rigging hardware and the safety factor associated with each item.
4. Select the correct equipment for rigging typical loads.
5. Describe hoisting and load moving procedures.

C. Hazardous Materials & Fire Protection ..... 2 Hours

Outcome: ***Describe the safety practices for hazardous materials and fire protection in the communication technician trade.***

1. Describe the roles, responsibilities features and practices related to the Workplace Hazardous Materials Information System (WHMIS) program.
2. Describe the three key elements of WHMIS.
3. Describe handling, storing and transporting procedures when dealing with hazardous materials.

4. Describe safe venting procedures when working with hazardous materials.
5. Describe fire hazards, classes, procedures and equipment related to fire protection.

D. Lab Safety Awareness and Hazardous Materials .....2 Hours

Outcome: ***Use appropriate safety procedures and equipment and work safely around hazardous materials.***

1. Describe the application of the following personal protective equipment:
   a) eye protection
   b) safety headgear
   c) respiratory protection
   d) clothing
   e) foot wear
   f) gloves
2. Describe the safe application of voltage testing equipment.
3. Describe the care and safe use of ladders.

SECTION TWO: .....BASIC ELECTRICITY .....52 HOURS

A. Electricity Fundamentals .....8 Hours

Outcome: ***Describe the basic fundamentals of electricity including Ohm's law, analytical troubleshooting, conductors, analog & digital meters and magnetism.***

1. Describe practical applications of the general principles of electricity.
2. Describe the components of basic circuits.
3. Define, give symbols, and state units of measurement for the following electrical terms:
   a) coulomb as a unit of charge
   b) volt as a unit of potential difference
   c) amp as a unit of current
   d) ohm as a unit of resistance
4. Describe the term closed circuit.
5. Describe the term open circuit.
6. Describe the term short circuit.
7. Explain direction of current:
   a) electron flow
   b) conventional flow
8. Describe the difference between alternating current and direct current.
9. State the forms of Ohm's Law.
10. Perform calculations using all forms of Ohm's Law.
11. Explain power dissipation and work in a resistance.
12. Calculate power dissipation in a resistance.
13. Explain the relationship between voltage, current, resistance and power.
14. State forms and perform calculations using power formulas.
15. Describe analog and digital multimeters.
16. Explain types of conductors and insulators used in communications.

17. Explain the effect of wire resistance in a circuit.
18. Define the following magnetic terms:
    a) magnetic field
    b) magnetic flux
    c) flux density
    d) induction by magnetic fields
    e) reluctance
    f) Ampere/turns
    g) field intensity
    h) Ohm's Law of magnetic circuits
    i) hysteresis
19. Identify the types of magnets:
    a) permanent
    b) electromagnet
20. Define permeability.
21. Explain magnetic shielding.

B. Passive Electrical Components.....8 Hours

Outcome: ***Explain the operation of passive electrical components including resistors, inductors, relays, capacitors and transformers.***

1. Explain resistors.
2. Explain the induction of current.
3. State Lenz's Law.
4. Explain the generation of induced voltage.
5. Describe typical electrical circuit components:
    a) switches
    b) fuses
    c) indicators
6. Describe relay function.

C. DC Circuits.....8 Hours

Outcome: ***Explain the operation of DC circuits and battery components.***

1. Define, calculate and analyze series, parallel, and series-parallel DC circuits.
2. Troubleshoot and analyze the effects of opens and shorts on a parallel circuit.
3. Describe types of grounding.
4. Describe DC power sources.
5. Explain internal resistance of power sources.

D. Small Signal AC Circuits.....6 Hours

Outcome: ***Describe small signal AC current and voltage, AC power sources, inductive circuits, capacitive circuits, RLC in AC circuits and resonance.***

1. Explain alternating current theory.
2. Identify sources of small signal sinusoidal AC wave forms.

3. Describe series and parallel inductive and capacitive AC circuits.
4. Describe XL and XC in terms of an ac impedance.
5. Calculate XL and L, or XC and C, and frequency given any two of the variables.
6. Add inductive reactance in series and parallel.
7. Identify applications of inductive and capacitive reactance.
8. Explain the term "back EMF".
9. Describe the hazards associated with the high voltage produced by opening RL circuits.
10. Explain how a charge is stored in a dielectric.
11. Explain the charging and discharging of capacitors.
12. Describe typical capacitors:
    a) electrolytic
    b) bipolar
13. Describe the effects of stray inductance and capacitance.
14. Explain AC maximum power transfer.
15. Explain transformer theory.

E. Analytical Troubleshooting.....4 Hours

Outcome: Employ analytical troubleshooting techniques.

1. Define analytical troubleshooting.
2. Describe analytical problem solving techniques.
3. Identify causes against known standards or specifications.
4. Explain how multi-problem resolutions are accomplished through analytical troubleshooting techniques:
    a) isolating
    b) prioritizing
    c) resolving

F. Basic Electricity Lab..... 18 Hours

Outcome: Execute various basic electricity lab exercises including work with meters, circuits, voltage dividers, transformers, cells, power supplies, oscilloscope, inductors, and capacitors.

1. Describe laboratory rules and procedures.
2. Correctly operate meters.
3. Test, measure and verify basic circuits.
4. Verify characteristics of loaded and unloaded voltage dividers.
5. Test transformers for input/output current and voltage characteristics.
6. Test cells and power supplies.
7. Measure and verify specified current characteristics using an oscilloscope.
8. Conduct specified lab exercises involving inductors.
9. Conduct specified lab exercises involving capacitors.

SECTION THREE: ..... TRADE MATHEMATICS ..... 12 HOURS

A. Advanced Mathematical Topics ..... 8 Hours

Outcome: ***Perform formula manipulation, solve the system of two equations and solve series/parallel circuit problems.***

1. Perform formula manipulation as applied to basic AC/DC problems.
2. Solve the system of two equations using methods of substitution and elimination.
3. Solve series/parallel circuit problems.

B. Alternative Numbering Systems ..... 4 Hours

Outcome: ***Define and manipulate alternative numbering systems.***

1. Describe binary numbering systems.
2. Describe hexadecimal numbering systems.

SECTION FOUR: ..... CABLE PLANT ARCHITECTURE I ..... 42 HOURS

A. Cabling Standards ..... 4 Hours

Outcome: ***Recognize and use the correct cabling standards and types of cables for given installations.***

1. Discuss the reasons for cabling standards.
2. Discuss the various cabling standards including:
   - a) International Organization for Standardization (ISO)
   - b) ISO 11801 (Generic Cabling for Customer Premises)
   - c) American National Standards Institute (ANSI)
   - d) Institute of Electrical and Electronics Engineers (IEEE)
     - i) IEEE 802.3 (Ethernet)
   - e) Electronic Industries Alliance (EIA)
   - f) Telecommunications Industries Association (TIA)
     - i) ANSI/TIA/EIA-568-B.1 (Commercial Building Telecommunications Cabling), Standard Part 1: General Requirements
     - ii) ANSI/TIA/EIA-568-B.2 and B.2-ad10 (Commercial Building Telecommunications Cabling), Standard Part 2: Balanced Twisted Pair Cabling Components
     - iii) ANSI/TIA/EIA-568-B.3, Standard Part 3: Optical Fibre Cabling Component Standard
     - iv) ANSI/TIA/EIA-569-A, (Commercial Building Standard for Telecommunications Pathways and Spaces)
     - v) ANSI/TIA/EIA-570-B (Residential and Light Commercial Telecommunications Wiring Standard)
     - vi) ANSI/TIA/EIA-606 (Administration Standard for the Telecommunications Infrastructure of Commercial Buildings)
     - vii) ANSI/TIA/EIA-607 (Commercial Building Grounding and Bonding Requirements for Telecommunications)
     - viii) ANSI/TIA/EIA-758 (Customer-owned Outside Plant Telecommunications Standard)
   - g) Canadian Standards Association (CSA)
     - i) Current CSA equivalent documents for above

h) Canadian Electrical Code (CEC) Sections (Currently C22.1-06)
   i) Section 10 (Grounding and Bonding)
   ii) Section 16 (Class 1 and Class 2 circuits)
   iii) Section 56 (Optical Fibre Cables)
   iv) Section 60 (Electrical Communication Systems)

B. Outside Plant Architecture (OSP) ..... 12 Hours

Outcome: Identify the equipment components and structures of outside plant architecture.

1. Describe the Serving Area Concept (SAC).
2. Describe underground, direct buried and aerial components for the following:
   a) OSP Infrastructure
   b) OSP Cable Structure and Cable Types
   c) OSP Cable Enclosures
   d) OSP Color Codes
   e) OSP Splicing Techniques

C. Inside Plant Architecture ..... 12 Hours

Outcome: Identify the equipment components and structures of inside plant architecture.

1. Describe Structured Cabling Systems (SCS) including:
   a) SCS Infrastructure
   b) Patch panels (PP)
   c) Cross-connects (X-Conn)
   d) Telecommunication Outlets (TOs)
   e) Multi-User Telecommunication Outlets (MUTOs)
   f) SCS Cable Structure and Cable Types
   g) SCS Color Codes
   h) SCS Termination Techniques
2. Describe the relationship of networking systems and topologies:
   a) architectures
   b) topologies
3. Describe building entrances and demarcation points:
   a) central office
   b) Main Distribution Frame (MDF)
   c) Intermediate Distribution Frame (IDF)
   d) Fibre Main Distribution Frame (FMDF)
   e) tie cables
   f) co-locate rooms
   g) customer premises
4. Identify and describe NID/NIB component parts.
5. Describe the function of NID/NIB component parts.
6. Describe the correct wiring configuration for NID/NIB protectors.
7. Describe protective devices.
8. Identify the appropriate protection devices to protect life and property of subscribers.
9. Describe telecommunication rooms (TR).

10. Describe vertical risers/backbone:
    a) Pathways, spaces and access panels
    b) cable types
        i) usage specifications
        ii) fire ratings

D. Bonding and Grounding.....2 Hours

Outcome: ***Use correct bonding and grounding equipment and procedures for a given installation.***

1. Explain the purpose of bonding and grounding:
    a) effects of lightning on communication systems
    b) effects of precipitation static on communication systems
2. Identify electrical safety regulatory bodies governing bonding and grounding of communication facilities:
    a) safety requirements for the last utility in
    b) procedures to be followed when foreign voltages have been located
    c) standard maximum measured voltage allowed before stopping work
3. Describe bonding and grounding requirements for communications equipment:
    a) remote sites
    b) Fibre Optic Transport System (FOTS) equipment
    c) Point of Presence (POP) equipment
    d) cellular sites
    e) customer premises
    f) subscriber carrier
4. Describe latest developments in anti-static protection:
    a) circuit pack handling
    b) anti-static flooring systems
    c) ground connections and maintenance
    d) anti-static mats and wrist straps
    e) static dissipative footwear

E. Cabling Lab..... 12 Hours

Outcome: ***Identify and use the correct tools to perform acceptable cable splicing and bonding & grounding procedures.***

1. Perform terminations on various blocks and panels:
    a) OSP cable testing methodology and required tools
    b) SCS cable testing methodology and required tools
    c) basic OSP cable splicing techniques
    d) basic SCS cable splicing and termination techniques
    e) basic bonding and grounding techniques

SECTION FIVE: ..... TELEPHONY ..... 28 HOURS

A. Communication Network Overview and Terms ..... 4 Hours

Outcome: ***Define the scope of the Communication Technician trade and be familiar with common terms associated with it.***

1. Outline the history of the telecommunication industry.
2. Describe the present telecommunication environment.
3. Identify emerging technologies, trends, and opportunities for future growth.
4. Describe various terms associated with the communication technician trade, including but not limited to:
    a) Co-Locate
        i) POI
        ii) POP
        iii) POT
    b) ILEC/CLEC Interconnect
    c) PRI
    d) Competitive Digital Network Access (CDNA)
        i) DS1
        ii) DS3
    e) GPS

B. Basic Telephone Line ..... 2 Hours

Outcome: ***Draw and interpret simple and complex telephone circuits and describe cable characteristics.***

1. Draw and explain a simple telephone circuit (telephone to central office).
2. Draw and explain a complex telephone circuit (loop improvement equipment –loop extenders, VFR's, loading schemes).
3. Describe cable characteristics.

C. Basic Telephone Set ..... 3 Hours

Outcome: ***Explain the operation of the basic telephone set.***

1. Identify components of a typical telephone set.
2. Explain the theory of operation of the following:
    a) transmitter
    b) receiver
    c) touch-tone pad
    d) hook switch
    e) ringer and capacitor
    f) network (sidetone)
3. Describe the characteristics of:
    a) 2500 set
    b) electronic set
    c) digital set
    d) cordless phones
    e) IP phones

D. Telecommunication Systems .....3 Hours

Outcome: ***Interpret block diagrams and describe the North American network systems, digital multiplexing, subscriber interfacing and basic signaling technology.***

1. Describe intra-office call systems.
2. Describe inter-office call systems:
   a) local
   b) 10 digit local dialing
   c) local number portability
3. Describe numbering schemes:
   a) North American
   b) World
   c) IP addressing
4. Describe the North American switched network:
   a) switching office arrangements
   b) Common Channel Signaling
5. Describe the long distance market:
   a) 1 – 800 service
   b) equal access toll and local access
6. Explain a block diagram of a telecommunication system that incorporates:
   a) telephone sets
   b) key equipment
   c) PBX and Centrex
   d) Virtual Corporate Network
   e) cellular/mobile
7. Explain a block diagram of a telecommunication system as it relates to multiplex and carrier systems:
   a) coaxial cable
   b) copper cable
   c) HF and VHF radio
   d) microwave
   e) satellite
   f) fibre optics

E. Basic Switching System Functions .....6 Hours

Outcome: ***Describe basic switching system functions including interconnecting, functions, control systems and power requirements.***

1. Describe interconnecting.
2. Describe the eight-step operation of a telephone call:
   a) alerting
   b) attending
   c) information transmitting
   d) information translating
   e) busy testing
   f) conversation
   g) supervision

h) clear & restore

3. Explain block diagrams of a telecommunication system as it relates to:
   a) distribution/concentration/expansion
   b) distributed versus common control
4. Describe DC power requirements of switching systems:
   a) -48 volt battery system

F. Basic Customer Terminal Equipment ..... 2 Hours

Outcome: ***Use a block diagram to describe the operation of basic customer terminal equipment and describe the technology trends with customer terminal equipment.***

1. Describe the operation of basic customer terminal equipment using a block diagram:
   a) fax machines
   b) modems
   c) Auto Call Distributor (ACD)
   d) pay phones
   e) Voice over Internet Protocol (VoIP)

G. Basic Telephony Lab ..... 8 Hours

Outcome: ***Perform various analyses of telephony operation.***

1. Measure voltage and current on the subscriber loop.
2. Measure frequency response on cables.
3. Perform decibel (dB) loss measurements.
4. Perform noise measurements.

SECTION SIX: ..... PRACTICAL IP FUNDAMENTALS I ..... 36 HOURS

A. Network Fundamentals ..... 8 Hours

Outcome: ***Describe networking and terminology.***

1. Define and explain the need for networking.
2. Discuss the historical progression of networking starting with ARPANET.
3. Define the following networking terms:
   a) client/server
   b) Network Operating System (NOS)
   c) peer-to-peer
   d) Local Area Network (LAN)
   e) Wide Area Network (WAN)
   f) Metropolitan Area Network (MAN)
   g) Network Interface card (NIC)
   h) switch
   i) router
   j) multicasting

B. Networking Standards .....6 Hours

Outcome: Describe and compare networking models and standards.

1. Explain the need for standards:
   a) IETF (Internet Engineering Task Force)
   b) ISO/ITU.(International Organization of Standards; International Telecommunications Union)
2. Describe the seven layers of the Open Systems Interconnect (OSI) model and its advantages:
   a) data encapsulation process in comparison to the OSI model
   b) OSI model as compared to the (Department of Defense) DOD model
   c) TCP/IP Protocols

C. Network Devices ..... 10 Hours

Outcome: Describe physical layer, data link layer and network layer devices.

1. Describe the function of the following layer 1 components:
   a) transmission media
   b) connection components (jacks, plugs, cables, patch panels)
   c) hubs
2. Describe physical LAN topologies:
   a) bus
   b) star
   c) ring
   d) mesh
3. Describe the function of the following Layer 2 components:
   a) NIC
   b) Media Access Control (MAC) addressing
   c) switches
4. Explain the concept of collision domains:
   a) Hubs versus switches
   b) Half Duplex versus Full Duplex
5. Describe Layer 2 functions and protocols
   a) Ethernet
      i) Collision Sense Multiple Access/Collision Detect (CSMA/CD)
   b) switches
   c) physical (hardware) address (MAC)

6. Describe Layer 3 functions and protocols:
   a) router
   b) broadcast domains
   c) network addressing
   d) logical (host) address (IP)
   e) network segments
   f) basic path determination
7. Describe where the devices fit within the enterprise network architecture:
   a) network hierarchy and basic design

D. IPv4 Addressing ..... 4 Hours

Outcome: Explain the purpose of IPv4 addressing.

1. Explain the process of converting decimal to binary and binary to decimal as it relates to the IPv4 addressing scheme.
2. Describe the classes and breakdown of IP addressing:
   a) classes
   b) public addressing versus private
   c) Unicast vs. multicast vs. broadcast
   d) reserved addresses including loopback
3. Explain IP subnetting.
4. Identify the common components of an IP addressing configuration on a host:
   a) client IP
   b) subnet mask
   c) gateway IP
   d) DNS IP
   e) Add section D Lab
5. Explain the use of Variable Length Subnet Masks (VLSM).

E. Network Lab ..... 8 Hours

Outcome: Construct a simple LAN.

1. Design an IP addressing plan
2. Build a simple LAN
3. Construct a simple internetwork.
4. Troubleshoot a simple internetwork.
5. Use a network Protocol Analyzer.

SECOND PERIOD TECHNICAL TRAINING
COMMUNICATION TECHNICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... ELECTRONICS ..... 20 HOURS

A. Power Supplies ..... 8 Hours

Outcome: Describe the operation of a power supply.

1. Describe the function of:
   - a) transformers
   - b) rectifiers
     - i) diodes
     - ii) zener diode
   - c) filters
   - d) regulators
2. Compare switching power supplies with legacy power supplies.

B. Amplifiers ..... 4 Hours

Outcome: Understand amplifier applications.

1. Describe the purpose of an amplifier:
   - a) amplifier black box parameters

C. Electronics Lab ..... 8 Hours

Outcome: Conduct various lab exercises on power supplies & regulators and amplifiers.

1. Identify and describe common lab equipment, procedures and safe use.
2. Measure and verify DC output and ripple.
3. Verify correct power supply function.
4. Verify correct amplifier operation.
5. Troubleshoot an amplifier line-up.
6. Troubleshoot a power supply system.

SECTION TWO: ..... CABLE PLANT ARCHITECTURE II ..... 64 HOURS

A. Analysis of Cable Plant Architecture (CPA) I Concepts ..... 4 Hours

Outcome: Discuss CPA I concepts.

1. Re-examine CPA I concepts:
   - a) the current industry acceptable cabling standards used
   - b) the differences of OSP and SCS
   - c) grounding and bonding requirements
   - d) evaluate procedures and practices

B. Copper Cable ..... 8 Hours

Outcome: ***Identify correct copper cable systems for higher data rates when planning and installing building wiring systems.***

1. Define and explain:
   a) noise
   b) crosstalk
   c) cable twists
   d) impedance
   e) attenuation
2. Define and explain coaxial cable:
   a) characteristics
   b) electrical properties
   c) use in network architecture
3. Define and explain:
   a) Unshielded Twisted Pair (UTP) characteristics
   b) Shielded Twisted Pair (STP) characteristics
   c) Screened Twisted Pair (ScTP) or Foil Twisted Pair (FTP) characteristics
4. Define and explain:
   a) channel and permanent link length required
   b) flammability ratings and fire-stop techniques
   c) advanced Unshielded Twisted Pair (UTP) categories

C. Balanced Twisted Pair Cabling Components ..... 6 Hours

Outcome: ***Identify the correct equipment required for high-speed (wide bandwidth) systems under the CSA/ANSI/TIA/EIA standards.***

1. Identify and describe copper cable termination components.
2. Identify and describe the following types of connectors:
   a) data
   b) 25-pair (BIXs, R66 and 110)
   c) coaxial
3. Identify and describe types of panels and blocks:
   a) patch panel
   b) punch-down block (RJ-45)
4. Describe application guidelines.
5. Describe work area outlets.

D. Fibre Optic Cable ..... 8 Hours

Outcome: ***Identify fibre optic (FO) cabling in planning and installation for building wiring systems under CSA/ANSI/TIA/EIA standards.***

1. Describe the following:
   a) Safe handling of fibre cable, tools, and equipment
   b) optical fibre cable types (Multimode and single mode)
   c) FO transmission performance (bandwidth) parameters

d) maximum attenuation and minimum return loss
e) types of FO equipment (i.e.: transmitters and receivers)
f) bend radius (static and dynamic)
g) aerial installation versus direct buried installation techniques
h) proper indoor installation practices
i) types of FO patch panels and splice enclosure
j) types of FO connectors

2. Troubleshoot fibre optics systems and perform acceptance tests using industry accepted hand-held meters.

E. Cable Administration ..... 4 Hours

Outcome: ***Understand and apply industry acceptable administration standards for OSP and SCS under CSA/ANSI/TIA/EIA standards.***

1. Describe the four classes of cable administration.
2. Describe the color coding labelling of termination fields.
3. Describe the labelling, linkage and report procedures.
4. Describe the color specifications.
5. Describe general cable documentation guidelines.
6. Describe electronic administration software.

F. Residential Building Concepts ..... 10 Hours

Outcome: ***Apply industry acceptable cabling standards for residential (home) systems under CSA/ANSI/TIA/EIA standards.***

1. Describe the components of the Residential Telecommunications Cabling Standard.
2. Describe the basic infrastructure of a home network cabling system.
3. Describe the proper procedures for installing a residential cable infrastructure.
4. Recognize and interpret the various residential cabling mediums used.
5. Describe the procedures required to test a completed cable system.

G. Methodology of Cable Testing ..... 8 Hours

Outcome: ***Plan a cable system that will meet or exceed the required standards for certification.***

1. Describe general cable installation guidelines.
2. Describe inter-building cables (backbone).
3. Explain how to terminate cables.
4. Describe building grounding and bonding (Under ANSI/TIA/EIA-607standard).
5. Explain surge protection.
6. Describe component, link and channel testing (with Labs).
7. Describe field testing methods (with Labs).
8. Explain the different types of copper certification tests (with Labs).
9. Explain FO certification tests.
10. Explain ISO/IEC cable tests.

11. Describe cable management systems.
12. Describe the convergence of LANs and cabling systems.

H. Advanced Building Wiring and Termination Lab ..... 16 Hours

Outcome: Use correct procedures for installing building wiring systems.

1. Demonstrate cable planning and layout to specified standards.
2. Install fibre optic and copper cabling.
3. Demonstrate patch panel terminating.
4. Terminate workstation outlets.
5. Perform cable testing and certification to specified standards.

SECTION THREE: ..... BASIC TRANSMISSION ..... 24 HOURS

A. Introduction ..... 10 Hours

Outcome: Describe basic transmission concepts of communication networks.

1. Identify and describe types of waveforms:
   a) sinusoidal
   b) non-sinusoidal
2. Describe the characteristics of pulse waveforms.
3. Describe the harmonic content of waveforms.
4. Describe bandwidth requirements of the following applications:
   a) human voice
   b) audio
   c) video
   d) LANs
   e) CATV
   f) wireless
5. Calculate and explain the relationship between:
   a) dB and power ratio
   b) dB and voltage ratio
   c) dBm and dB relative to a reference
6. Define the following terms:
   a) logarithms
   b) decibels dB
   c) decibel Levels dBm, dBW, dBmV, dBrn
7. Describe the use and application of the following meters:
   a) level meters (dB/dBm)
   b) digital dBm meter
8. Describe the following reading types:
   a) bridged
   b) terminated
   c) common errors

9. Describe Test Level Points (TLP), Data Level Points (DLP) and system level measurements.
10. Define the concept of dBm0.

B. Four-Wire Terminal Networks and Hybrid Circuits ..... 2 Hours

Outcome: ***Explain attenuation, identify selected types of attenuators, and identify & manipulate hybrid circuits.***

1. Describe attenuation and attenuators.
2. Describe Characteristic Impedance.
3. Identify and describe types of hybrids.
4. Discuss hybrid losses:
   a) insertion
   b) hybrid
   c) trans-hybrid
   d) return loss
5. Explain echo and singing.
6. Define standard test tone levels for hybrid circuits.
7. Describe balancing a network and compare with balancing a line.

C. Transmission Line Parameters ..... 2 Hours

Outcome: ***Explain transmission lines parameters.***

1. Describe transmission line parameters:
   a) Characteristic impedance
   b) Attenuation
   c) Matching
      i) Cause and effect of reflection due to mismatch
      ii) Equalization and matching techniques
      iii) Phase compensation
   d) Frequency response/bandwidth
2. Describe propagation constants:
   a) attenuation/decay
   b) phase relationships (graphical representation)
   c) velocity and velocity factor
   d) effect of loading coils

D. Basic Transmission Lab ..... 10 Hours

Outcome: ***Perform prescribed lab exercises with decibel measurements, pads & attenuators, transmission lines, cable loading, TDR measurements, hybrid circuits and noise measurements.***

1. Measure pulse characteristics.
2. Perform decibel measurements.
3. Verify Zo and loss characteristics of pads and transmission lines.
4. Verify transfer characteristics of loaded and non-loaded lines.
5. Perform Time Domain Reflectometer (TDR) measurements.

6. Perform decibel measurements for a hybrid circuit.
7. Perform noise measurements on transmission mediums.

SECTION FOUR: ..... FIBRE OPTICS ..... 32 HOURS

A. Introduction to Fibre Optics Theory ..... 16 Hours

Outcome: ***Explain the operation of fibre optics including light transmission, optical fibre, cables & cable connectors, transmission & reception, system components and testing.***

1. Discuss the history of fibre optics.
2. Describe information transmission.
3. Identify and describe the advantages of fibre optics.
4. Contrast and compare copper and fibre.
5. Describe safety issues associated with:
   a) glass fibre
   b) laser equipment and tools
6. Describe electromagnetic spectra.
7. Describe geometrical optics:
   a) reflection and refraction
   b) Snell's Law
   c) Principle of total internal reflection
   d) Fresnel reflection
8. Describe optical fibre construction.
9. Describe optical fibre classifications:
   a) multimode step index fibre
   b) multimode graded index fibre
   c) single mode step index fibre
10. Describe optical fibre characteristics:
    a) modal dispersion
    b) material dispersion
    c) dispersion shifted fibre
    d) fibre bandwidth
    e) numerical aperture and the number of modes
    f) attenuation, scattering and transmission windows
11. Describe buffer types.
12. Describe inside plant cables.
13. Describe outside plant cables.
14. Describe connector basics and requirements.
15. Identify and describe types of connectors.
16. Describe splices:
    a) fusion splice
    b) mass fusion splice
    c) mechanical splice
17. Describe passive couplers.

18. Describe light sources and transmitters:
    a) LED and laser
    b) light modulation and basic transmitter topology
    c) transmitter power rating
19. Describe detectors and receivers:
    a) PN, PIN and APD detectors
    b) noise in photo detectors
    c) basic receiver concepts
20. Describe loss budget.
21. Describe bandwidth budget.
22. Describe Dense Wave Division Multiplexing (DWDM).
23. Describe optical fibre signal regeneration techniques.
24. Describe fibre networks:
    a) computer system network
    b) broadband application
25. Discuss current trends in fibre networks:
    a) Fibre to the Curb (FTTC)
    b) Fibre to the Home (FTTH)
    c) Fibre to the Building (FTTB)
    d) Video On demand (VOD)
26. Identify test equipment.
27. Describe standard tests:
    a) OFSTP-14
    b) FOTP-141
    c) FOTP-61
28. Describe optical time domain reflectometry (OTDR).

B. Fibre Optics Lab ..... 16 Hours

Outcome: Perform connectorization, fibre splicing, loss measurement and OTDR testing.

1. Install hot melt connectors:
    a) fibre preparation
    b) installing the connector
    c) connector polishing
    d) connector inspection and loss estimation
2. Perform fusion splicing.
3. Perform loss measurement using light source and power meter.
4. Perform OTDR testing:
    a) understanding of OTDR equipment and the dead zone
    b) basic OTDR testing
        i) fibre attenuation
        ii) splice loss
        iii) link loss

SECTION FIVE: .....PRACTICAL IP FUNDAMENTALS II..... 40 HOURS

A. Switching and Virtual LANs (VLAN) .....10 Hours

Outcome: Describe the functional characteristics of switches and VLANS.

1. Describe the initial configuration of a switch:
   - a) Connection parameters on communication port
   - b) Using the Command Line Interface (CLI)
     - i) Authorization and authentication
     - ii) Remote access
2. Describe the physical and logical function of a switch:
   - a) MAC address table structure
   - b) spanning tree protocol (STP)
     - i) flood, filter, forwarding operation
     - ii) STP domains
3. Describe the functionality of VLANs:
   - a) purpose of VLANs
   - b) IEEE 802.1Q
   - c) Access and trunk links
   - d) The voice VLAN
   - e) The management VLAN

B. Inter VLAN Communications.....8 Hours

Outcome: Describe the components of interVLAN communications.

1. Describe network segmentation using VLANs and VLSM.
   - a) multiple spanning tree implementations
2. Describe components for interVLAN communications.
   - i) router
   - ii) layer three switch (L3)

C. Practical IP Fundamentals II Lab .....22 Hours

Outcome: Perform prescribed lab exercises including building a basic LAN and testing its functionality.

1. Perform fundamental switch configuration
   - a) Placement of ethernet switches in the network
   - b) Local switch access
   - c) Naming the switch
   - d) Address the switch
   - e) Remote switch access
2. Perform simple switch administration
   - a) Verify MAC address table
   - b) Verify and/or configure spanning tree protocol
3. Configure VLANs in a LAN
   - a) VLAN identifiers and names
   - b) Access link
   - c) Trunk links

4. Observe spanning tree protocol (STP) behaviour
   a) Modify STP configuration for VLANs
5. Configure inter-VLAN communications
   a) Using a router
   b) Using a layer 3 switch
   c) Using a customer design scheme
   d) multiple spanning tree implementations
6. Troubleshooting a LAN:
   a) impact of legacy equipment
      i) cabling issues
      ii) obsolete equipment
   b) Layer 2 switching issues
      i) Loops
      ii) Broadcast storms
   c) VLAN issues
      i) Management VLAN
      ii) Spanning tree
      iii) Trunking
      iv) Inter-VLAN communication

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THIRD PERIOD TECHNICAL TRAINING
COMMUNICATION TECHNICIAN TRADE
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UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:.....ACCESS TECHNOLOGY I..... 60 HOURS

A. Overview of Data Communications ..... 8 Hours

Outcome: ***Describe a basic data communications system including terminology, transmission modes, standards organizations and terminal emulation software.***

1. Describe the fundamentals of a data communications system:
   a) Transmitter
   b) Transmission medium (copper, fibre, wireless)
   c) Receiver
   d) Analog and digital signals
   e) Frequency spectrum and bandwidth
2. Identify transmission modes:
   a) Simplex
   b) Full-duplex
   c) Half-duplex
3. Describe terms associated with a data communications system:
   a) Data Communications Equipment (DCE)
   b) Data Terminal Equipment (DTE)
   c) Digital/Data Service Unit/ Channel Service Unit (DSU/CSU)
   d) Protocols
   e) Topology
   f) Connection-oriented
   g) Connectionless
   h) Dedicated
   i) Point-to-point
   j) Multipoint
   k) Point-to-multipoint
   l) Triple-play
4. Identify standards organizations for data communications:
   a) International Organization for Standardization (ISO)
   b) International Telecommunications Union (ITU)
   c) Institute of Electrical and Electronic Engineers (IEEE)
   d) American National Standards Institute (ANSI)
   e) Electronic Industry Alliance (EIA)
   f) Telecommunications Industries Association (TIA)
   g) Internet Engineering Task Force (IETF)
5. Discuss terminal emulation software:
   a) Hyperterminal
   b) Tera Term
   c) Putty

B. Requirements of Analog and Digital Transmission ..... 8 Hours

Outcome: ***Describe the requirements for analog and digital transmission including the characteristics of copper wire, line impairments, interface standards and the plain old telephone system.***

1. Describe characteristics of the copper pair:
   a) line coefficients; Resistance, Inductance, Conductance, and Capacitance
   b) cable gauges
   c) cable make-up
   d) automatic Line Build-Out (ALBO)
2. Describe line impairments that can occur with analog and digital signals:
   a) attenuation
   b) attenuation distortion
   c) phase and group delay
   d) envelope delay distortion (EDD)
   e) crosstalk
3. Identify requirements for analog transmission:
   a) balance
   b) power influence
   c) impedance mismatch
   d) noise
   e) loop length
   f) loop current
4. Identify requirements for digital transmission:
   a) effect of load coils
   b) bridge taps
   c) jitter
   d) wander
   e) Intersymbol Interference (ISI)
5. Identify signal interface standards:
   a) RS-232, 422, 423, 449, 530
   b) Breakout box
   c) DB-9, DB-25
   d) RJ-10, 11, 12, 14, 45, 48 C
   e) USB 2.0/3.0, USB to Serial RS-232
6. Describe the Plain Old Telephone System (POTS):
   a) Subscriber's loop
   b) Access lines
   c) Digital Loop Carrier (DLC)

C. Characteristics of Pulses And Digital Signals ..... 6 Hours

Outcome: ***Describe characteristics of pulses and digital signals.***

1. Describe characteristics of an ideal pulse:
   a) amplitude
   b) width
   c) period

d) mark
e) space
f) duty cycle
g) leading edge
h) falling edge

2. Describe characteristics of a non-ideal pulse:

a) rise time
b) fall time
c) tilt
d) fractional tilt

3. Describe harmonic analysis of waves (Fourier series).

4. Describe time domain.

5. Describe frequency domain.

6. Explain Shannon's theorem.

D. Line Encoding Techniques And Data Transmission Speeds .....4 Hours

Outcome: Describe line encoding techniques and data transmission speeds.

1. Describe line encoding techniques:

a) reasons for line encoding
b) baseband signals
c) requirements for line encoding
d) non Return to Zero (NRZ)
e) return to Zero (RZ)
f) alternate Mark Inversion (AMI)
g) Manchester
h) Bipolar Non Zero Substitution (BnZS)
i) zero-suppression techniques
j) Reed-Solomon codes (R-S)
k) Cyclic Redundancy Check (16-bit/32-bit)

2. Describe data transmission speeds:

a) DS-0, DS-1, E-1, DS-3
b) OC-1, 3, 12, 48, 192, 768
c) Frame Relay, ATM
d) DSL, FTTH, Wireless systems (802.xx)

E. Digital Modulation Techniques and Data Compression .....4 Hours

Outcome: Describe digital modulation techniques and data compression.

1. Describe digital modulation schemes:

a) Bits per second versus Baud
b) Frequency Shift Keying (FSK)
c) Phase Shift Keying (PSK)
d) Quadrature Phase Shift Keying (QPSK)
e) Quadrature Amplitude Modulation (QAM)
f) Minimum Shift Keying (MSK)

2. Explain the need for data compression:
   a) Joint Photographic Expert Group (JPEG)
   b) Moving Picture Experts Group (MPEG)
   c) Coder/Decoder (CODEC)

F. Access Lines ..... 6 Hours

Outcome: ***Describe access lines including Digital Subscriber Line and how it interfaces with the Integrated Services Digital Network.***

1. Describe Digital Subscriber Line (DSL) including its various versions:
   a) DSL loop requirements
   b) Describe network tiering connectivity options:
      i) single homed
      ii) multi homed
   c) connectivity issues
   d) Asymmetrical Digital Subscriber Line 2 (ADSL2+)
   e) Digital Subscriber Line Access Multiplexer (DSLAM)
   f) ADSL Transceiver Unit-Central office (ATU-C), ADSL Transceiver Unit-Remote (ATU-R)
   g) DSL splitter technology
   h) Discrete MultiTone (DMT) modulation, 2 binary 1 quaternary (2B1Q), Carrierless Amplitude Phase (CAP)
   i) High-bit-rate DSL (HDSL)
2. Describe the Integrated Services Digital Network (ISDN)
   a) components
   b) channels
   c) access types
   d) devices

G. Carrier Facilities ..... 8 Hours

Outcome: ***Describe carrier facilities including the T-1 carrier system, Wide Area Networking (WAN) technologies, and Ethernet basics.***

1. Describe the T-1 carrier system:
   a) Time Division Multiplexing (TDM)
   b) framing: D1, D4 (Superframe SF), D5, Extended Superframe (ESF)
   c) synchronization
   d) T-1 span problems
   e) channel banks
   f) T-1 testing; test patterns, Bipolar Violations (BPVs), Loss of signal (LOS), Loss of frame (LOF), more than 15 consecutive zeros
   g) Bit Error Rate Test (BERT)
   h) alarms: red, yellow, blue
   i) regenerative repeaters
   j) power feed to repeaters
   k) transmission media for T-1
2. Describe Wide Area Networking (WAN) technologies:
   a) North American Digital Hierarchy
   b) Asynchronous Transfer Mode (ATM)
   c) Synchronous Optical Network (SONET)

3. Describe the Ethernet:
    a) advantages
    b) standards
    c) IEEE format
    d) Ethernet frame
    e) Ethernet speeds: 10 Mbps, 100 Mbps, 1 Gbps, 10 Gbps

H. Access Technology I Lab ..... 16 Hours

Outcome: Perform prescribed lab exercises on a communication system

1. Configure a T-1 line.
2. Troubleshoot a T-1 line.
3. Configure a DSL line.
4. Test a DSL line.
5. Verify the operation of a QAM modulator.
6. Identify the components in a SONET infrastructure.

SECTION TWO: ..... TRANSPORT TECHNOLOGIES ..... 24 HOURS

A. Introduction to Multiplexing Fundamentals ..... 8 Hours

Outcome: Describe multiplexing and the digital hierarchy.

1. Define multiplexing and how it fits into telecommunications systems.
2. Describe types of multiplexing including:
    a) Frequency Division Multiplexing (FDM)
    b) Time Division Multiplexing (TDM)
    c) Statistical Time Division Multiplexing (STDM)
    d) Wave Division Multiplexing (WDM)
3. Describe the creation of a digital bit stream (Pulse Code Modulation (PCM)):
    a) sampling
    b) quantizing
    c) encoding
4. Discuss the multiplexing of bit streams:
    a) creation of a level one Digital Signal (DS-0)
        i) frames
        ii) synchronization methods
        iii) signaling
    b) North American digital hierarchy
        i) DS-1 signal format
        ii) DS-2 signal format
        iii) DS-3 signal format
    c) European digital hierarchy
        i) E-1 signal format
        ii) E-2 signal format
        iii) E-3 signal format
        iv) E-4 signal format
    d) Synchronous Digital Hierarchy (SDH)
    e) Plesiosynchronous Digital Hierarchy (PDH)

5. Describe the optical multiplexing hierarchy:
   a) Building integrated timing supply
   b) Synchronous Transport Signal (STS)
   c) Optical Carrier level One (OC-1)
   d) Optical Carrier level Three (OC-3)
   e) Optical Carrier level Twelve (OC-12)
   f) Optical Carrier level Forty-Eight (OC-48)
   g) Optical Carrier level One Ninety Two (OC-192)
   h) Optical Carrier level Seven Sixty-Eight (OC-768)
6. Discuss wavelength division multiplexing terminology:
   a) Lambda (λ)
   b) Common wavelengths (850 nm, 1300 nm, 1550 nm)
   c) Passive Optical Network (PON)
   d) Coarse Wavelength Division Multiplexing (CWDM)
   e) Dense Wavelength Division Multiplexing (DWDM)

B. Multiplexing Systems ..... 8 Hours

Outcome: Describe network multiplexer systems.

1. Discuss multiplexing devices:
   a) M1-3 multiplexer
   b) Smart Channel Banks
      i) Fractional T1
      ii) DS0 (single data channel)
   c) Sub Rating
   d) Digital Subscriber Line Access Multiplexers (DSLAM)
   e) Statistical Multiplexing
      i) Asynchronous Transfer Mode (ATM)
   f) Coarse Wavelength Division Multiplexing (CWDM)
   g) Dense Wavelength Division Multiplexing (DWDM)
   h) Passive Optical Network (PON)
2. Describe the applications of network multiplexing devices:
   a) access
      i) channel banks
      ii) Coarse Wavelength Division Multiplexers (CWDM)
      iii) passive optical splitters
   b) distribution
      i) Digital Access Cross-connect System (DACS)
      ii) Mini-DACS
   c) core
      i) Add-Drop Multiplexer (ADM)
      ii) Dense Wavelength Division Multiplexer (DWDM)
      iii) Optical Cross-Connect (OXC)

C. Transport Technologies Lab ..... 8 Hours

Outcome: Perform selected transport technologies lab exercises.

1. Configure various types of end-to-end circuits.
2. Configure a DSL.

SECTION THREE: .....NOISE MITIGATION..... 16 HOURS

A. Introduction.....4 Hours

Outcome: ***Define noise, noise types, noise measurement and describe the various sources of noise and their effects.***

1. Define and explain noise in relation to transmission:
   - a) mitigation
   - b) importance to transmission
2. Define the basic noise types:
   - a) white, thermal, random
   - b) cross talk
     - i) near end cross talk (NEXT)
     - ii) far end cross talk (FEXT)
   - c) impulse
   - d) intermodulation
   - e) quantization
3. Describe noise measurement:
   - a) dBm & levels
   - b) dBrn
   - c) dBrnC and C filter
   - d) milliwatt supply
   - e) correct termination requirements
4. Describe the various sources of noise:
   - a) AC power influence
   - b) central office power supply
   - c) electromagnetic inductance
   - d) radio frequency interference
   - e) effects of temperature on noise
   - f) electrical devices
   - g) singing/echo
   - h) lightning
   - i) electric motors
   - j) background
5. Identify and describe transient noise sources on communication facilities:
   - a) sheath currents
   - b) line surges
   - c) static

B. Influencing Factors .....4 Hours

Outcome: ***Describe influencing factors including power system design and telephone & power line misbalance causes.***

1. Explain basic power system design and concepts:
   - a) power distribution
   - b) power neutrals
   - c) single wire ground return

d) AC grounding methods
e) return currents

2. Identify and explain power system characteristics:

a) balanced/unbalanced loads
i) feedback current
b) sinewave & harmonics
c) power abnormalities
d) transient power
e) transverse & longitudinal currents

3. Explain the theory of twisted pair noise coupling:

a) inductive
b) capacitive

C. Noise Mitigation Techniques and Devices ..... 4 Hours

Outcome: Identify and explain noise mitigation techniques and devices.

1. Explain the methods and theory of the following techniques:

a) equipment shielding and shielding currents
b) surge protection
c) grounding, bonding and single point grounding system (SPGS)
d) Multi ground Neutral (MGN)

2. Identify and describe the devices designed to minimize mitigation:

a) isolation transformers
b) noise filters
c) chokes
d) drain coils
e) induction neutralizing transformers
f) surge protectors

D. Noise Measurement and Equipment Lab ..... 4 Hours

Outcome: Use selected noise measurement equipment and perform noise measurement tests.

1. Perform noise measurements with associated equipment:

a) measure loop parameters using milliwatt supply
b) measure battery and rectifier noise
c) show noise measurement errors
d) perform harmonic distortion measurements
e) find faults using artificial line
f) perform balance and noise tests

SECTION FOUR: ..... DC POWER PLANTS ..... 24 HOURS

A. Safety Requirements ..... 2 Hours

Outcome: Apply safety regulations and practices when working with DC power plants.

1. List and describe safety regulators and the scope of regulations:

a) WHMIS
b) Canadian Electrical Code

c) Electrical Protection Act
d) Transportation of Dangerous Goods (TDG)

2. Describe the legal aspects of safety.
3. List and describe battery and rectifier safety considerations.
   a) Safe DC power plant inspection and maintenance practices
4. List and describe required personal protective and safety equipment.
5. Describe general safety rules on DC power plants.

B. Introduction to DC Power Plants ..... 6 Hours

Outcome: ***Describe the basic components and purpose of DC power plants and explain AC theory as applied for conversion from AC to DC.***

1. Identify and describe the basic components of a DC power plant.
2. Describe the purpose of DC power plants.
3. Explain AC theory for conversion from AC to DC.
4. Explain uninterruptible power supplies (UPS).
5. Describe how control panel functions are accomplished:
   a) Microprocessor control systems
   b) Remote control administration.

C. Batteries ..... 4 Hours

Outcome: ***Describe basic battery components and use batteries safely in a variety of operating conditions.***

1. Describe basic battery components:
   a) Lead acid
   b) Absorbed Glass Mat (AGM)
   c) Gel Cells
2. Describe battery voltages:
   a) 12 volts
   b) 52.8 volts
   c) 54 volts
3. Explain the theory of battery charging and discharging.
4. Describe the effects of temperature on batteries.
5. Describe battery safety rules.
6. Describe methods for inspecting and cleaning batteries.

D. Rectifier Operation ..... 2 Hours

Outcome: ***Describe basic rectifier components and the functions of secondary power plant inverters and converters.***

1. Identify and describe basic rectifier components.
2. Describe the operation of ferroresonant, SCR, and switch mode rectifiers including controls, alarms, and connections.
3. Describe rectifier safety rules.
4. Describe the application of meter shunts in rectifier circuits.

5. Describe the function of an inverter.
6. Draw a basic block diagram of a typical inverter and label each component.
7. Describe the function of a converter.
8. Describe a basic block diagram of a typical converter and label each component.
9. Describe the purpose of a converter common panel.

E. Distribution and Alarms ..... 2 Hours

Outcome: ***Describe the distribution of DC power plants and explain the operation of combined, rectifier and fuse alarms.***

1. Describe the power distribution architecture of a DC power plant.
2. Explain how rectifier alarms are identified as minor and major.
3. Describe fuses:
   a) Types
   b) Selecting and replacing fuses
4. Describe local and remote alarm monitoring systems.

F. Alternate Power Sources ..... 2 Hours

Outcome: ***Describe various types of generating alternate power.***

1. Discuss alternate methods of generating power:
   a) portable and on-site generated primary and stand-by power sources
   b) solar
   c) wind
   d) micro-hydroelectric
2. Discuss methods of emergency DC power restoration.

G. Power Plant Lab ..... 6 Hours

Outcome: ***Perform prescribed measurements and adjustments on power plant equipment.***

1. Perform the following measurements:
   a) battery float voltage
   b) battery equalize voltage
   c) AC distribution voltage
   d) shunt voltage measurement
   e) strap test voltage drop
   f) specific gravity
   g) individual cell voltage
      i) pilot cell
   h) temperature
   i) voltage drop from rectifier to battery string
2. Perform the following adjustments:
   a) rectifier float voltage
   b) rectifier equalize voltage
   c) rectifier current limit adjustment

SECTION FIVE: ..... PRACTICAL IP FUNDAMENTALS III ..... 56 HOURS

A. Routers ..... 10 Hours

Outcome: Describe physical and logical router characteristics.

1. Describe common router components such as:
   - a) Read Only Memory (ROM)
   - b) Flash memory
   - c) Non-volatile Random Access Memory (NVRAM)
   - d) Random Access Memory (RAM)
   - e) Router operating system
   - f) Router interfaces
     - i) Ethernet/Fast Ethernet
     - ii) Serial Interfaces
2. Discuss router configurations:
   - a) access methods used to configure a router
     - i) Communication port
     - ii) Telnet/SSH
     - iii) Auxiliary port
   - b) user, privileged and configuration modes
     - i) help function options of a router
     - ii) configuration editing options
   - c) router configuration modes
     - i) global parameters
     - ii) interface parameters
     - iii) routing parameters
3. Describe the functional characteristics of a typical router:
   - a) routing table
   - b) packet forwarding
   - c) broadcast domain
   - d) boot sequence

B. Routing Protocols ..... 10 Hours

Outcome: Describe routing mechanisms and protocols.

1. Static versus dynamic routing
2. Routing Protocols:
   - a) Interior protocols versus exterior protocols
3. Identify current interior routing protocols:
   - a) distance vector
     - i) Routing Information Protocol (RIPv2)
   - b) link state
     - i) Open Shortest Path First (OSPF)
   - c) routing metrics
   - d) administrative distances
4. Describe the effects of routing pathway changes:
   - a) default routing
   - b) routing updates

c) routing loops
d) route summarization using Classless Interdomain Routing (CIDR)

C. Security Fundamentals ..... 10 Hours

Outcome: Describe basic LAN security features.

1. Discuss basic connectivity terminology:
   a) Firewall
   b) Proxy Server
   c) Demilitarized zone (DMZ)
   d) Connectivity authentication
      i) Access Control Lists (ACL)
      ii) 802.1X
      iii) Remote Access Dial In User Service (RADIUS)
      iv) Virtual Private Network (VPN)
      v) IPSec and Secure Socket Layer (SSL)
2. Explain Network Address Translation (NAT)/Port Address Translation (PAT):
   a) NAT versus PAT
   b) static translations versus dynamic translations
   c) scenarios for mandatory translations
   d) configuration parameters
3. Describe Access Control Lists (ACL):
   a) standard
   b) extended
   c) placement of ACLs
4. Virtual Private Networks
   a) Explain the business case for VPNs
   b) Site-to-Site vs. client server
   c) IPSec vs. SSL
   d) Authentication and encryption

D. Practical IP Fundamentals III Lab ..... 26 Hours

Outcome: Perform prescribed lab exercises including configuring basic routing protocols and security on infrastructure devices.

1. Configure routing on an internetwork
   a) RIPv2
   b) OSPF
   c) Verify the routing table
2. Troubleshoot routing problems:
   a) Configuration problems
   b) Cabling issues
3. Configuration a VPN
4. Troubleshoot a VPN

FOURTH PERIOD TECHNICAL TRAINING
COMMUNICATION TECHNICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:.....VOICE NETWORKS ..... 40 HOURS

A. Concepts and Structure of Voice Networks ..... 12 Hours

Outcome: ***Discuss the overall concepts, components and their associated protocols of traditional voice networks.***

1. Define key terms associated with voice networks:
   - a) Public Switched Telephone Network (PSTN)
   - b) digital switching equipment
     - i) DMS (NORTEL)
     - ii) GTD5 (AG COMM Systems)
   - c) trunks and lines
   - d) circuit switching
   - e) hosts/remotes
2. Describe the architecture of a typical switch:
   - a) Central Processing Unit (CPU)
   - b) operating system software
   - c) switch fabric
   - d) peripheral processor
     - i) Line cards
     - ii) Trunk cards (switch ports)
     - iii) DS-0 Time Slot Assignment (TSA)
3. Compare circuit switching with packet switching.
4. Identify voice network component placement using a block diagram:
   - a) switching plan
   - b) customer connectivity
     - i) PBX
     - ii) CENTREX option
     - iii) Individual line service
   - c) cellular connectivity
5. Discuss the interrelationship of voice network components:
   - a) numbering plans
     - i) Telephone Number (TN)
     - ii) North American numbering plan
     - iii) World numbering plan

B. Key Systems, PBX and Centrex Service ..... 4 Hours

Outcome: Discuss digital key systems, PBX and Centrex service.

1. Describe the organization, operation and features of the following:
   - a) digital key system
   - b) PBX system
   - c) CENTREX service
2. Discuss current/emerging technologies:
   - a) IP-PBX
   - b) IP trunking
   - c) communication servers

C. Voice Network Protocols ..... 8 Hours

Outcome: Describe the signaling used in the public switched telephone network.

1. Describe the concept of Common Channel Signalling (CCS7):
   - a) architecture and operation
   - b) CCS7 applications/Call Management System (CMS)
     - i) Local Number Portability (LNP)
     - ii) Advanced Intelligent Network (AIN)
     - iii) 1-800 numbers

D. Voice Networks Lab ..... 16 Hours

Outcome: Perform selected switching systems lab exercises.

1. Perform exercises on PBX systems.

SECTION TWO: ..... PRACTICAL IP FUNDAMENTALS IV ..... 48 HOURS

A. Routing Foundations II ..... 6 Hours

Outcome: Discuss higher level protocols and IP conservation.

1. Describe IPv6:
   - a) addressing scheme
   - b) implementation
     - i) methods
     - ii) hardware requirements
     - iii) software requirements
     - iv) routing issues
     - v) configuration issues

B. The Supernet ..... 2 Hours

Outcome: Describe the Alberta Supernet.

1. Discuss the development of the Supernet.
2. Describe the topology of the Supernet.
3. Describe network structure of the Supernet.

4. Discuss the access methodology used for the Supernet including:
   a) Border Gateway Protocol (BGP)
   b) Multiprotocol Label Switching (MPLS)
5. Describe the access policy of the Supernet.

C. Quality of Service (QoS) ..... 8 Hours

Outcome: Describe basic QoS functionality.

1. Discuss the need for QoS:
   a) effects of network congestion
   b) reasons for traffic priorization
   c) explain the process of end-to-end QoS
      i) customer network
      ii) provider network
      iii) Customer Edge to Provider Edge (CE/PE)
2. Describe techniques for managing QoS :
   a) access
      i) traffic marking with Differentiated Services (DiffServ)
      ii) trust
      iii) queuing
      iv) marking enforcement
   b) core congestion avoidance
      i) traffic shaping
      ii) traffic policing
3. Describe common congestion management schemes including:
   a) Queuing
      i) First In First Out (FIFO)
      ii) Class-Based Weighted Fair Queuing (CBWFQ)
      iii) Low Latency Queuing (LLQ)
   b) Compression
   c) Explicit Congestion Notification (ECN)
4. Explain the use of common congestion avoidance techniques such as:
   a) Tail drop
   b) Weighted Random Early Detection (WRED)

D. Wireless LANs..... 8 Hours

Outcome: Describe wireless LAN terminology, standards, devices and site preparation requirements.

1. Explain wireless LAN terminology:
   a) Service Set Identifier (SSID)
   b) beacon interval
   c) basic security settings
      i) Wired Equivalency Privacy (WEP)
      ii) security key methods
      iii) open access issues

d) configuration tools
   i) broadcasting networks
   ii) signal strength
   iii) autoconnect issues
e) hot spot types

2. Describe wireless standards:
   a) IEEE 802.11a/b/g/n
   b) IEEE 802.16
   c) Bluetooth

3. Describe consumer wireless hardware:
   a) Wireless Access Point (AP)
   b) wireless bridges
   c) antenna types
      i) omnidirectional
      ii) directional/unidirectional
      iii) Multiple Input/Multiple Output (MIMO)
      iv) connector types
   d) other devices
      i) Personal Digital Assistant (PDA)
      ii) wireless peripherals
      iii) VoIP phones

4. Describe practical applications of wireless communications technology:
   a) ad hoc versus infrastructure
   b) trusted vs. untrusted
   c) environmental considerations

5. Describe site preparation requirements:
   a) Site Survey
   b) proximity to electro-magnetic interference
   c) signal barriers/deadspots
      i) ductwork
      ii) rf influences
      iii) channel separation

6. Identify attenuating obstacles to wireless security:
   a) WEP vs. WPA (WiFi Protected Access)
   b) VPN

E. Practical IP Fundamentals IV Lab ..... 24 Hours

Outcome: ***Perform prescribed LAN Lab exercises.***

1. Implement IPv6 on an internetwork
2. Implement quality of service on an internetwork
3. Introduce and configure a wireless component to an internetwork
4. Troubleshoot issues on an internetwork

SECTION THREE: ..... IP TELEPHONY AND UNIFIED COMMUNICATIONS..... 32 HOURS

A. Protocols .....6 Hours

Outcome: Describe selected VoIP protocols keyed to the OSI model.

1. Describe the following protocols with reference to the OSI model:
    a) Real-time Transport Protocol/Real-time Transport Control Protocol (RTP/RTCP)
    b) H.323 Protocol Suite
    c) Session Initiation Protocol (SIP)
    d) Voice Codecs
        i) G.711 (PCM)
        ii) G.722
        iii) G.722.1
        iv) G.728
        v) G.729
        vi) Internet Low Bit-rate Codec (ILBC)
        vii) AAC-LD
        viii) MPEG-4

B. VoIP Topology.....8 Hours

Outcome: Compare enterprise, consumer and carrier VoIP topologies and identify how they integrate with the public telephone network.

1. Describe the requirements of an enterprise VoIP topology:
    a) security and design issues
    b) soft phone clients versus physical VoIP phones
    c) interfacing to the PSTN
2. Discuss carrier IP telephony for consumer and enterprise solutions:
3. Describe a hybrid approach to VoIP
4. Describe interfacing VoIP with the public telephone network (PSTN).

C. Alternative VoIP Methods .....2 Hours

Outcome: Compare the approaches to VoIP taken by selected providers and discuss emerging trends with VoIP.

1. Describe consumer VoIP offerings including:
    a) Skype
        i) Software IP phone
    b) Vonage
        i) Telephone adapter devices
2. Describe emerging trends with IP telephony:
    a) Wireless (cellular/ WiFi/ dual-mode)

D. IP Telephony and Unified Communications Lab ..... 16 Hours

Outcome: Perform prescribed IP telephony lab exercises.

1. Demonstrate the sending and receiving of IP telephony calls.
2. Demonstrate the capturing of IP telephony call traffic to analyze packet structure/packet loss using Wireshark® and other technologies.
3. Use a progressive design approach and a common lab topology to:
   a) design and configure the basic lab IP telephony LAN
   b) configure the above lab to interface with the public telephone network
   c) configure the above lab to add gateway protocols to enable site-to-site internetworking
   d) configure the above lab for a multi-branch enterprise solution
4. Implement QoS on an IP telephony internetwork.
5. Troubleshoot voice quality issues and implement voice quality solutions.

E. Workplace Coaching Skills ..... 2 Hours

Outcome: Display coaching skills.

1. Describe coaching skills used for training apprentices.

F. Alberta's Industry Network ..... 1 Hour

Outcome: Describe the Alberta Industry Network.

1. Describe Alberta's apprenticeship and industry training system.
2. Describe the roles and responsibilities of the Alberta Apprenticeship and Industry Training Board, government and post-secondary institutions.
3. Describe the roles and responsibilities of the PACs, LACs and occupational committees.

SECTION FOUR: ..... VIDEO ..... 32 HOURS

A. Video Transmission and Consumer Products ..... 24 Hours

Outcome: Describe video transmission fundamentals including TV transmission, National Television System Committee (NTSC), baseband video, broadband video, Broadband ISDN, digital video, video compression, Advanced Television System Committee (ATSC) (also known as HDTV), transport systems and transmission standards and consumer video products.

1. Describe the fundamentals of TV transmission:
   a) historical development of television
2. Describe the following systems:
   a) National Television System Committee (NTSC)
      i) describe synchronization
      ii) describe blanking
      iii) colour
      iv) luminance
   b) Phase Alternate Line (PAL)
   c) Sequential Color With Memory (SECAM)
   d) Advanced Television System Committee (ATSC)

i) Digital Television (DTV)
ii) High Definition Television (HDTV)

e) Serial Digital Interface (SDI)
i) Component Analog Video (CAV)
ii) Analog to Digital Conversion (A to D)

3. Describe interlacing and progressive scanning.

4. Describe equalization.

5. Describe resolution issues.

6. Describe broadband video:

a) Cable Television (CATV) distribution

7. Describe B-ISDN.

8. Describe video compression:

a) Motion Picture Expert Group (MPEG) II
b) H.261
c) H.263/H.263++
d) MPEG IV
e) H.264

9. Describe standard and high definition TV aspect ratios.

10. Describe video signal formats and transport systems:

a) Serial Digital Interface (SDI)
b) Asynchronous Serial Interface (ASI)

11. Describe consumer video products including:

a) Set top box (STB)
i) Personal Video Recorder (PVR)
b) High Definition Multimedia Interface (HDMI)
c) Digital Video Interface (DVI)
d) Component Video Cable
e) Serial Video (S-Video)
f) Display types
i) Cathode Ray Tube (CRT)
ii) Liquid Crystal Display (LCD)
iii) Plasma
iv) Digital Light Processing (DLP)
v) Organic Light-emitting Diode (OLED)

12. Describe streaming video:
    a) Video On Demand (VOD)
    b) Internet Protocol Television (IPTV) (topology diagram)
    c) Cellphone/Laptop TV
13. Describe broadcast TV versus IPTV
    a) Advantages and disadvantages of each

B. Video Lab ..... 8 Hours

Outcome: ***Perform lab exercises including test and measurement procedures on common signal faults, video signal generation methods, wave form recognition and manipulation techniques, video connectivity, and selected consumer video installation configurations.***

1. Perform selected test and measurement procedures on faulty signals.
2. Generate video signals including:
    a) MPEG
    b) NTSC
    c) HDTV
3. Manipulate wave forms.
4. Set up various video configurations.
5. Set up various consumer video installation configurations.

SECTION FIVE: ..... ACCESS TECHNOLOGIES II ..... 32 HOURS

A. Data Terminology ..... 2 Hours

Outcome: ***Explain selected data terminology.***

1. Explain selected data terminology:
    a) Connection-oriented
    b) Connectionless- oriented
    c) Virtual circuit
    d) Data-Circuit Terminating Equipment (DCE)
    e) Data Terminal Equipment (DTE)
    f) Switched Virtual Circuit (SVC)
    g) Permanent Virtual Circuit (PVC)
    h) Ethernet Virtual Connection (EVC)
    i) User-to-Network Interface (UNI)
    j) Network-to-Network Interface (NNI)
    k) Quality of Service (QoS)
    l) Service Level Agreement (SLA)

B. Access Technologies Protocols ..... 6 Hours

Outcome: ***Discuss selected protocols and standards in use on data networks.***

1. Describe Virtual Private Networks (VPN) basics:
    a) VPNs versus leased lines
    b) VPN benefits
    c) VPN types

d) VPN components
e) VPN tunneling

2. Describe Multi Protocol Label Switching (MPLS) basics:

a) MPLS acronyms
b) MPLS components
c) Label Switching Path (LSP)
d) Label Switching Routers
e) Ingress and Egress
f) MPLS fault tolerance and path recovery

3. Describe carrier Ethernet basics:

a) Ethernet Virtual connections (EVCs)
b) E-Line, E-LAN, E-Tree services
c) UNI types
d) Metro Ethernet Network (MEN)
e) Ethernet Private Line (EPL)
f) Ethernet Virtual Private Line (EVPL)
g) Ethernet Private Tree (EP-Tree)
h) Virtual Private Tree (EVP-Tree)
i) Ethernet speeds

C. Copper-Based Access Technologies ..... 6 Hours

Outcome: Describe copper-based access technologies.

1. Describe twisted pair cable arrangements:

a) Very-high-speed DSL (VDSL)
b) Very-high-speed DSL Line 2 (VDSL2)
c) VDSL2 Bonding
d) Vectored DSL
e) Outside Plant (OSP) requirements for DSL and variants
f) DSL hardware: ATU-R, ATU- C, DSLAM, DSL Modem
g) Measuring DSL performance
h) Home Phone Networking Alliance (HPNA) 2.0, 3.0, 3.1

2. Describe coaxial cable arrangements:

a) Cable infrastructure; headend, feeder cable, drop cable, terminal equipment
b) Cable Modem Terminating System (CMTS)
c) Hybrid Fibre Coax (HFC)
d) Data Over Cable Service Interface Specification (DOCSIS) : 1.0, 2.0, 3.0Discuss fibre-based access devices:

3. Discuss RF-based devices:

a) Wireless Fidelity (Wi-Fi)
b) Worldwide Interoperability for Microwave Access (WIMAX)
c) Evolution-Data Optimized (EVDO)
d) High Speed Data Packet Access (HSDPA)
e) Satellite (internet access)

D. Fibre-Based Access Technology ..... 6 Hours

Outcome: Discuss the use of fibre-based access technologies.

1. Discuss the advantages to fibre-based technologies.
2. Describe the Passive Optical Network (PON).
3. Describe the Gigabit Passive Optical Network (GPON).
4. Describe network types:
   a) Fibre-to-the-node (FTTN)
   b) Fibre-to-the-Curb (FTTC)
   c) Fibre-to-the-Home (FTTH)
   d) Fibre-to-the-Building (FTTB)
   e) RF over glass (RFoG)
5. Describe upstream and downstream wavelengths and speeds.
6. Describe optical splitters.
7. Describe the Fibre Distribution Hub (FDH).
8. Discuss Wavelength Division multiplexing (WDM).
9. Discuss the performance characteristics of GPON.
10. Discuss testing using the Optical Loss Test Set (OLTS) and the Optical Time Domain Reflectometer (OTDR).

E. RF-Based Access Technologies ..... 4 Hours

Outcome: Discuss the use of RF-based access technologies.

1. Describe WiFi: standards, frequencies, range.
2. Discuss Worldwide Interoperability for Microwave Access (WiMAX):
   a) applications
   b) frequencies
   c) range
   d) fixed and mobile WiMAX
   e) architecture
   f) WiFi versus WiMAX
3. Discuss Evolution Data Optimized (EVDO):
   a) advantages over WiFi
   b) download speeds
   c) EVDO modems
4. Discuss High-Speed Data Packet Access (HSDPA):
   a) applications
   b) transmission speeds
5. Discuss satellite technology:
   a) block diagram of a satellite communications system
   b) satellite bands
   c) satellite orbits
   d) Global Positioning Satellite (GPS)- trilateration
6. Describe Radio Frequency Identification (RF ID).

F. Access Technologies II Lab ..... 8 Hours

Outcome: ***Perform prescribed lab exercises on a communication system.***

1. Configure a VDSL line.
2. Test a VDSL line.
3. Simulate and test a FTTH network.
4. Configure a wireless Ethernet bridge.

SECTION SIX: ..... WIRELESS SYSTEMS ..... 56 HOURS

A. Wireless Transmission ..... 14 Hours

Outcome: ***Describe Radio Frequency (RF) fundamentals, transmission lines, radio wave propagation and antennas.***

1. Discuss the history of wireless communication.
2. Describe the radio frequency spectrum and convert between frequency and wavelength.
3. Describe the propagation of radio waves in free space:
   a) calculate power density and electric and magnetic field intensity for waves propagating in free space
   b) calculate free space attenuation and path loss
   c) perform calculations to determine the maximum communication range for line of site propagation
   d) describe ground, space and sky wave propagation
4. Explain path loss and fading in a mobile environment and how such an environment differs from free space.
5. Explain the operational principles of antennas:
   a) radiation
   b) isotropic
   c) dipole
   d) gain
   e) beam width
   f) band width
   g) polarization
   h) impedance
6. Describe the gain, bandwidth and application of each of the following antennas:
   a) half wave dipole
   b) folded dipole
   c) ground plane
   d) Yagi
   e) collinear
   f) horn
   g) parabolic
7. Explain the use of diversity and downtilt in base station antennas.
8. Describe transmission lines and connectors used in wireless applications:
   a) propagation constant
   b) power handling
   c) coaxial

d) waveguide
e) connectors

9. Describe standing waves:

a) impedance mismatches
b) Voltage Standing Wave Ratios (VSWR)
c) reflection coefficient
d) retum loss

B. Conventional FM Radio Communication Fundamentals ..... 4 Hours

Outcome: Describe FM radio system concepts and components.

1. Explain a block diagram of a basic FM transceiver:

a) RF amp
b) mixer/modulator
c) oscillator
d) limiter
e) discriminator/detector
f) filters
g) Input/Output Devices (I/O)
h) squelch circuits

2. Identify and describe types of mobile radio systems:

a) simplex
b) half duplex
c) full duplex
d) repeatered

3. Describe VHF/UHF devices and components:

a) duplexers
b) combiner
c) multi couplers
d) impedance matching
e) isolators
f) circulators
g) matched loads

4. Describe methods of using tie lines for remote control of base station transmitters and extending coverage.

5. Describe the trunking concept.

C. Analog and Digital Cellular Radio Telephone Service ..... 6 Hours

Outcome: Explain the operation of cellular radio telephone systems.

1. Describe the evolution of the analog mobile telephone system:

a) General Mobile Telephone Service (GMTS)
b) Improved Mobile Telephone Service (IMTS)
c) Advanced Mobile Phone Service (AMPS)

2. Describe the cellular concept:
   a) clustering
   b) frequency re-use
   c) cell splitting
3. Explain the operation of the North American digital cellular telephone systems.
4. Describe digital techniques utilized for conserving spectrum:
   a) Time Division Multiple Access (TDMA)
   b) Code Division Multiple Access (CDMA)
   c) Global System for Mobile communications (GSM)
   d) Universal Mobile Telephone System (UMTS)

D. Satellite Based Systems ..... 3 Hours

Outcome: Describe satellite based systems including block diagrams and system applications.

1. Describe the basic block diagram for a satellite system.
2. Describe satellite earth orbits:
   a) Low Earth Orbit (LEO)
   b) Medium Earth Orbit (MEO)
   c) Geostationary Earth Orbit (GEO)
3. Explain system applications:
   a) C band
   b) Ku band
   c) Direct To Home (DTH)
   d) Internet satellite service
   e) Low Earth Orbit cellular systems

E. Wireless Applications ..... 4 Hours

Outcome: Describe applications that use a wireless medium.

1. Describe applications of wireless devices including:
   a) paging systems
   b) wireless LAN devices (printers, cameras, etc)
   c) hot spots
   d) computer peripherals
   e) remote control devices
      i) RF
      ii) Infrared
   f) Bluetooth devices
   g) Global Positioning System (GPS)
   h) Supervisory Control and Data Acquisition (SCADA)

F. Trends in Wireless Technology ..... 3 Hours

Outcome: Describe emerging trends in wireless technology.

1. Explain the convergence of voice, video and data over wireless networks including:
   a) Short Message Service (SMS)
   b) Smart phones (email, scheduler, PC functionality)
   c) Cellphone videoconferencing

d) Multimedia Messaging Service (MMS)
e) Mobile TV

2. Discuss the convergence of entertainment into wireless devices including:

a) Downloadable content (eg ringtones, music files, games)
b) Streaming content (eg television, video on demand)
c) Interactive content (eg internet, on line gaming)

G. Towers ..... 2 Hours

Outcome: ***Describe towers including types, grounding arrangements, lighting & appearance and safety precautions.***

1. Describe self-supporting and guyed towers.
2. Describe tower anchors.
3. Describe tower grounding.
4. Describe tower lighting and painting.
5. Describe tower safety precautions.

H. Broadband Radio Communication Fundamentals ..... 4 Hours

Outcome: ***Describe broadband radio communications through block diagrams and applications.***

1. Discuss the components of a broadband radio system using a block diagram.
2. Identify and describe applications of broadband communication systems.

I. Wireless Systems Lab ..... 16 Hours

Outcome: ***Perform selected lab exercises involving mobile radio, cellular radiotelephone, microwave, satellite, path profiling and antenna radiation pattern equipment.***

1. Measure the following transmitter characteristics:

a) transmit power
b) transmit frequency
c) transmit deviation

2. Measure the following receiver characteristics:

a) 20 dB quieting sensitivity
b) 12 dB SINAD sensitivity
c) modulation acceptance bandwidth

3. Carry out antenna performance measurements:

a) Voltage Standing Wave Ratio (VSWR)
b) Return Loss

4. Position Direct to Home (DTH) antennas.
5. Measure gain, half power beamwidth, and front to back ratio characteristics of a gain antenna.
6. Perform an RF site survey of an existing WiLAN system.
7. Change WiLAN setting and re-do site survey.

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